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Shear Performance of Fibre Reinforced Concrete Beams: A General Review

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ABSTRACT

This paper reviewed emblematic discussion on behaviour of concrete composite beam subjected to monotonic and cyclic loading as tentative analysis contributes through the research of the review. The main discussion is commonly about the shear behaviour of beams made-up of various structural members, were tested at various loading condition. Dissimilar volume fractions have been used in the fibrous concrete beams of the test program as shear reinforcement. The use of fibres is particularly attractive if conservative stirrups can be eliminated, which reduces reinforcement congestion. The fibres can make the failure mode more ductile by increasing the tensile strength of concrete. The literature available on beam has been extensively searched for getting a platform for the start of research on the behaviour of concrete composite beam is deserted briefly. Finally, general concluding remarks are made along with possible suggestions for prospect directions of research.

Keywords: Beam, Monotonic and Cyclic Loading, Shear Behaviour, Fibres, Volume Fractions, Conservative Stirrups.

1. INTRODUCTION

Pertaining to the shear failure of concrete members, it is well known that when principal tensile stresses exceed the tensile strength of concrete, diagonal cracks occur in the shear span, Chalioris et al (2011). The use of discontinuous, randomly oriented fibres has long been recognized to provide post-cracking tensile resistance to concrete. Thus, their use as shear reinforcement in reinforced concrete (RC) beams has been the focus of several investigations in the past four decades, Hai H. Dinh et al (2010). In general three different failures modes to consider: flexural failure, flexural failure followed by shear failure, and abrupt shear failure without shear failure. For the latter two cases relatively small *a/d* are involved, and as part of the experimental program, material and structural test are performed for the RC and SFRC beams under low-to high shear-to-moment ratios, Thomas et al (2012). The addition of fibres to a reinforced concrete beam is known to increase its shear strength and if sufficient fibres are added, a brittle shear failure can be suppressed in favour of more ductile behaviour, Vinu R. Patel et al (2010). Aggregate interlock is one of the main contributions to the shear strength of concrete members, it have found that the shear strength of prestressed Self-Consolidating Concrete (SCC) beams is slightly less than that of prestressed normal concrete (NC) beams due to the smaller amount of aggregate used in the SCC, Chien-Hung et al (2012)[4]. The performance of two RC deep beams with large openings under monotonically increased concentric loading. The observed ultimate strengths and failure modes of these specimens were compared with those predicated by a design Strut and Tie Model (STM), two geometrically similar SFRC specimens with a 1.5% fibre-volume fraction, Dipti R. Sahoo et al (2010).

2. EXPERIMENTAL PROGRAMME

2.1. Test specimens

Out of twelve beams of 300 mm, 600 mm and 1200 mm overall depth, four beams of each size were tested. Two different percentages of horizontal shear reinforcement were used namely 0.2% and 0.3% of the gross area of beam section. The grouping of beams is Series I, II, and III as BS-300-0.2-UN, BM-600-0.2-UN, BL-1200-0.2-UN by Appa Rao (2012). Five specimens had no conventional shear reinforcement (partially without stirrups) whereas two beams had closed steel stirrups with diameter of 8 mm at uniform spacing of 200 mm for effective depth and the length of the beam is 275 mm and 1600 mm respectively, the influence of the steel fibres on the shear response of concrete beams under monotonic loading and cyclic loading is experimentally investigated, the study contributes to the rather limited existing on shear testing of fibrous concrete beams under cyclic deformations by Chalioris et al (2011). A total of 18 longitudinally reinforced concrete beams consisting of 9 beams made of SCC and 9 of CVC were tested in the investigation. The testing beams of three depths viz. 200 mm, 30 mm and 500 mm and length of the beams were 1732 mm, 2420 mm and 3792 mm respectively by Bhupinder singh et al (2010). The beams in the flexural test had open stirrups only in the shear span, whereas the beams in the shear tests had open stirrups over the length of 3030 mm, depth as 250 mm and breath of the beam as 125 mm, three beams were casted with various volume fractions of 0, 0.5 and 0.75% were investigated, while two steel reinforcing ratios of 1 and 1.5% by Thomas H. (2012). Sunilaa George et al (2010) used the RCC beam for shear failure was done for a span of 1.5 m without shear reinforcements or stirrups, 0.25 m overhang was provided on the either side of the beam to accommodate sufficient anchorage length. Beams were casted for various percentage replacements with 10%, 20%, 30%, 40%, 50% and 60% with activated fly ash and compared with fly ash without any activation and control mix with 0% replacement of cement. Vinu R. Patel et al (2010) tested on twelve beams, simply supported on constant effective span of 1200 mm under two point symmetrical loads. All the beams were having different depth of 300 mm, 400 mm, 500 mm and 600 mm and each series

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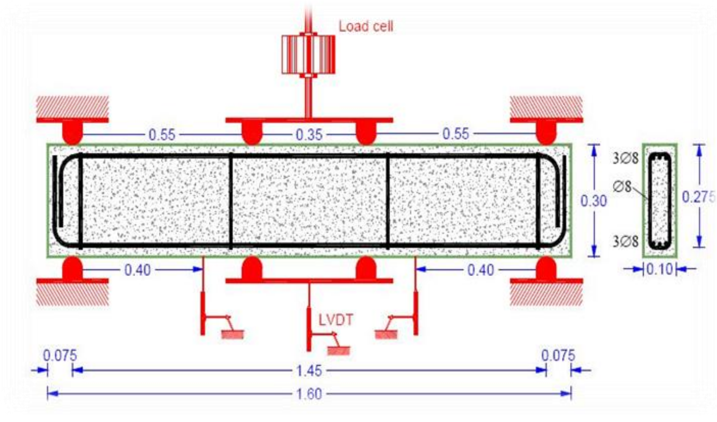

Figure 1
Test Setup

comprised of three beams on which the axial concrete strain was measured on surface planes situated at different depths of 0.0 cm, 5.0 cm and 7.5 cm across the width of the beam.

2.2. Test procedure

All the beams were tested up to failure under three-point loading with two simple supports, steel bearing plates of size 150 mm x 100 mm x 20 mm were provided above the roller supports, and also loaded in 6000 kN capacity load controlled system. LVDT were mounted to measure the central deflection of the beams by Appa Rao (2012). The beams were tested as simply supported members under a four-point loading configuration shown in fig.1. A stiff spreader beam was used to transfer the load from hydraulic ram to the test beams. The monotonically nine to ten increments until failure and it were recorded with the help of LVDT by Bhupinder singh et al (2010). Chalioris C.E et al (2011) used the beams were edge-supported on roller supports 1.45 m apart. The imposed loading was applied in two points in the mid-span of the beam loading was imposed consistently in low rate and was measured by a load cell with an accuracy of 0.05 kN. Dipti R. Sahoo et al (2010) used the RC deep beams with large discontinuous region were considered as test specimens in this study. The test specimens were ¼ scale models of an example deep beam originally, totally four numbers of specimens were carried out for the study. The reinforcing bars required by the STM, however, were eliminated and replaced by steel fibres in the SFRC specimens, in which steel bars were used only for longitudinal tensile reinforcement. The beams were tested under gradually applied load on UTM, three dial gauges were used at the bottom of beam to measure the deflections under the loading condition done by Vinu R. Patel et al (2010).

3. DISCUSSIONS OF RESULT

The first diagonal crack was formed at a stress of 4.76 MPa. The cracks were observed diagonally joining the support and the load point. Further, with the increase in the load, the diagonal cracks started to widen. At a stress greater than 11.38 MPa, several diagonal cracks were observed, which joined the support and the load point at a stress of 12.00 MPa alleged by Appa Rao (2012). Bhupinder singh et al (2010) deliberate the large size SCC as well as CVC beams had more number of cracks compared to the smaller sized beams. The experimentally observed first diagonal cracking and ultimate loads of 106.6 kN and 135.9 kN respectively are identified in the load-deflection transmit of the beam. The SCC beams varied in the range 83%-100% compared to the range 76%-92% for the corresponding CVC beams. Diagonal cracks formed in the shear span of the tested beams that exhibited shear failure. The applied various the crack width of the monotonically tested beams. The ultimate deflection of these beams at failure is also reported as decreasing. In all the beams specimens, initiation of cracks was from the bottom of the beams. In most of the cases the shear cracks are inclined and their direction of propagation was towards the nearest load point irrespective of its place of origin resulted by Vinu R. Patel et al (2010).

4. SUMMARY AND CONCLUSIONS

There has been a non negligible size effect on the diagonal cracking of RC deep beams, in which as the beam depth increases from 600 mm to 1200 mm, the diagonal cracking strength is found decrease. Very strong size effect has been observed in RC deep beams on the ultimate shear strength. About 35-55% decrease in the shear strength was observed when the beam depth was increased from 300 mm to 1200 mm. The post-diagonal cracking shear resistance capacity (derived from aggregate interlock plus dowel action) was relatively lower in the SCC beams compared to the CVC beams. Based on the experimental result of steel fibrous beams, it can be deduced that fibrous beams showed overall shear performance since they exhibited increased shear strengths, ultimate deflections and energy dissipation capacities regarding to the corresponding non-fibrous control specimens. The behaviour of the deep beams with large openings that were designed using STM. To investigate the effect of local strengthening on the load-transferring mechanism and failure modes of test specimens. To study the behaviour of SFRC specimens and compare that the behaviour with that of RC specimens designed using STMs. A ductile plastic mechanism developed after the formation of several plastic hinges in specimen SFRC. Due to the modified strength increased by the addition of fibres, PPFRC beams show enhanced shear strength and energy distribution capacity. Due to the polypropylene fibres, the shear stress of a fibre reinforced concrete beam increase, further mode, the failure made of the beam is changed to be more ductile. The shear strength of PPFRC increase by 80 to 85% due to addition of 1% polypropylene fibres which helps to reduce stirrups requirement.

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